What is the Smart Grid and Why Are We Talking About It at ESIP?

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What is the Smart Grid?

Smart Grid has been mentioned in presidential speeches, has almost $5 billion allocated to it in the American Reinvestment and Recovery Act (ARRA, aka the Stimulus Package), and even has a feature article in the July 2010 issue of ***National Geographic.*** But ***what*** is it? The Smart Grid will transform our current grid into an automated electric power system that monitors and controls grid activities, ensuring the two-way flow of electricity and information between power plants and consumers—and all points in between.

If that's a "Smart" Grid, does that mean we have a "Dumb" Grid?

Why do we need a "smart" grid when the National Academy of Engineering calls the North American electric power grid the greatest engineering achievement of the 20th century? Others have called the current grid the world's biggest machine. How dumb can it be with those sorts of credentials?

Well, right now the grid is so dumb that:

- The only way your utility knows if there is a power outage is when customers start to telephone the customer service hotline.
- The only way the utility knows what broke to cause the power outage is to wait for enough calls that it can use its GIS to plot out where on its grid topology the outage exists. It then it makes a ***guess*** as to what piece of equipment failed to cause the outage. Then it sends a technician ***in a truck*** to see if the guess was right. Once the failed equipment is identified, it sends ***another truck*** and more technicians to ***finally*** replace the broken equipment and turns the lights back on. (Oh, and sometimes the new equipment blows up right away turning the lights right back off.)
- Your utility either has to wait for equipment to fail, causing economic damage and leaving 1000s of customers in the dark or waste $100,000s replacing perfectly good equipment to avoid large outages.
- A fallen tree in Ohio brought 50 million people and the entire east coast to a standstill.
- You are charged the same price for electricity all year long – even though the cost of that electricity can vary by more than 2 orders of magnitude.
- It can only handle electricity flowing in one direction.
- It produces ~2.5 billion metric tons of CO_2 per year.

OK you've convinced me; the grid is dumb and we need to make it smarter.

How can the system be so dumb?

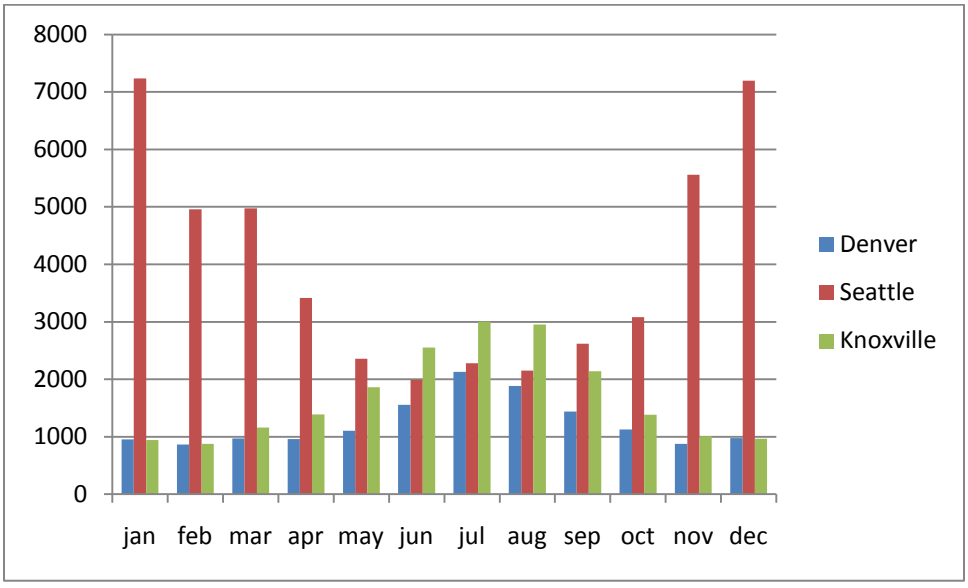
Please note: I said the grid was dumb, not the utilities. Utilities, in general, are very sophisticated businesses with lots of smart people working for them. Their problem is that most of their data is collected using 1920's technology: that good old reliable meter with the funny dials sitting under glass on the back of your house or apartment building.

Well if the utilities are so smart why don't they buy some decent sensors? Money! A smart meter and the communications infrastructure to support it cost up to $200 per house compared to $40 for an old style meter. Utilities are mostly a regulated monopoly and they have to get permission to pass those costs along to rate payers like you and me. Right now Pacific Gas and Electric in CA is being sued for installing smart meters by a consumer advocacy group. Just last month, the Maryland PUC rejected Baltimore Gas and Electric's Smart Grid proposal even though it meant losing $130 million in "free" money from the previously mentioned ARRA projects fund. Understandably, utility executives and their board of directors are leery of investing millions in technology that they may never be paid for.

Why is this something ESIP needs to know about?

In short the SmartGrid is about putting computing and information technology into all levels of the electric power system. It's about using modern sensors to give information to utilities so that they can make better decisions. That and the whole 2.5 billion tons of CO_2 per year.

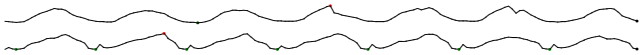
Here is what the utility and the home owner knows about the annual energy consumption of a typical house located in Knoxville, Denver, and Seattle.



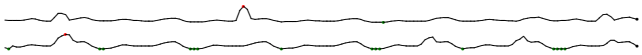
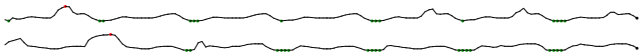
A comparison of 3 houses over the course of 12 months results in a whopping total of only 36 measurements!

Here's what SmartGrid could tell us for just two interesting weeks: one that includes the highest hourly consumption for the year and one that includes the lowest hourly consumption for the year. In this case we are looking at 1008 data points: 3 houses, 2 weeks of 168 hourly values each.

Energy Consumption for the Week Containing the Peak Hour of the Year

Hourly Energy Consumption For 1 Week (kWh)	Last [min | max]	City	Week of	Peak Hour
	1.560 [0.591 | 10.40]	Knoxville	7/29-8/3	Aug 1 16:00
	0.615 [0.503 | 4.037]	Denver	7/14-7/20	Jul 17 @17:00
	8.225 [1.530 | 15.80]	Seattle	**2/27-3/5**	**Mar 2 @06:00**

Energy Consumption for the Week Containing the Minimum Hour of the Year

	1.341 [0.614 | 4.511]	Knoxville	12/8-14	Dec 12 @1:00
	0.818 [0.503 | 2.260]	Denver	3/6-12	**Mar 9 @14:00**
	1.735 [0.850 | 6.933]	Seattle	6/12-18	Jun 15 @1:00

Notice all the rich information we can glean from this data:

- Knoxville and Denver have their peak consumption on a summer afternoon, while Seattle's is on a winter morning.
- The lowest consumption in Knoxville and Seattle is in the middle of the night. Denver's is in the middle of the afternoon.
- The weeks with the lowest consumption have a very flat profile. The peak weeks are very spiky.

The graphics above show simulated data for a 2500 sq ft two-story house built to ASHREA 90 standards located in the 3 cities listed. The Knoxville and Denver houses used a gas furnace, standard air conditioner, and gas hot water heating. The Seattle house used an electric furnace and hot water heater (typical for the northwest) but was otherwise identical to the other 2 houses.

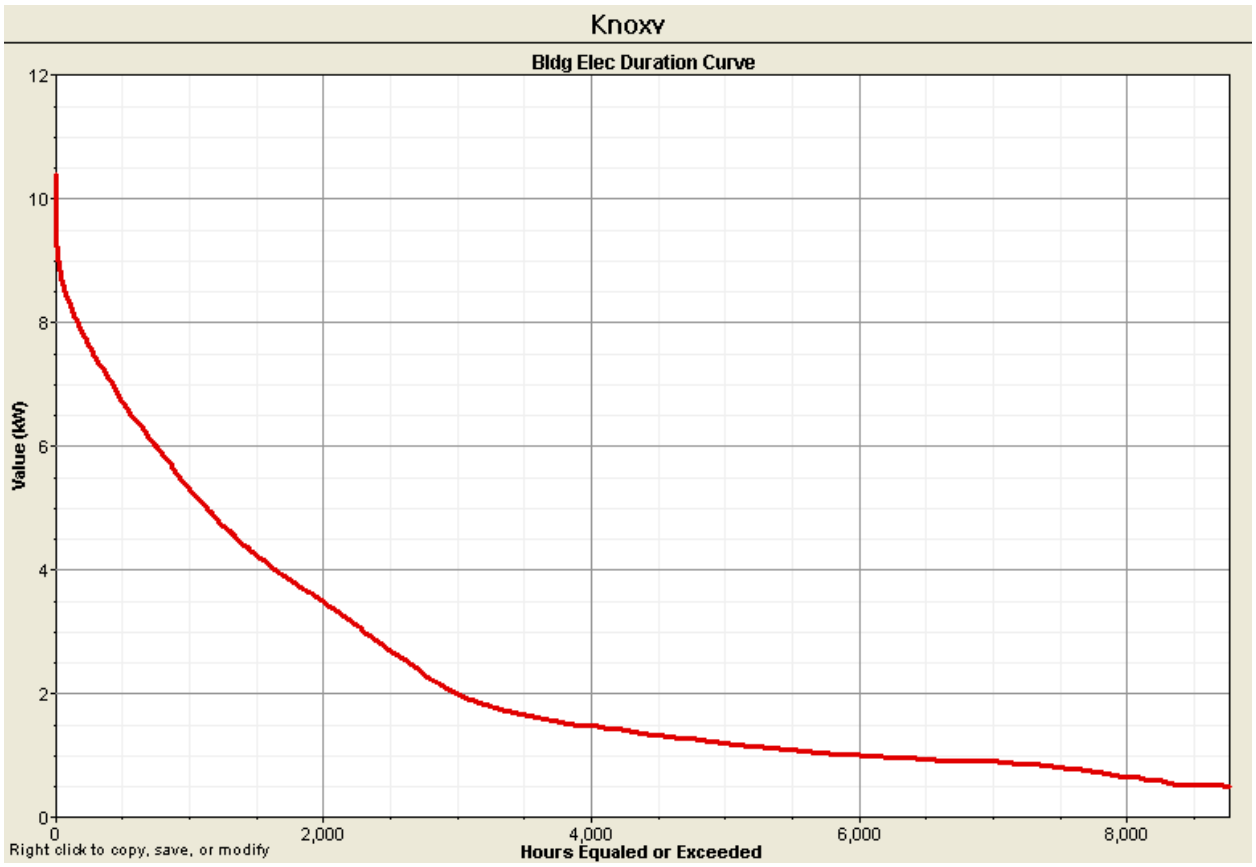
The data was generated using Energy-10, an award winning building energy simulation tool. Energy-10[1] uses typical meteorological year (TMY2[2]) data for the specific location to drive its simulation. The simulation performs hour-by-hour energy balances for all building elements as well as the mechanical equipment in the simulated building.

Why is this Extra Information So Important?

Above I mentioned the mismatch between the price we pay for the electricity and the cost of generating that electricity. Not only does electricity generation have vastly different costs over the year, it has vastly different levels of GHG production intensity. The high cost times are also the high pollution generating times. The reason for the massive cost and pollution differential is tied up with the different amounts of demand during different parts of the year and different hours in the day. The utility industry uses a graphic called the load duration curve to visualize this problem.

[1] Learn more about Energy-10 at http://www.psic.org/displaycommon.cfm?an=1&subarticlenbr=112

[2] A TMY is a data set of hourly values of solar radiation and meteorological elements for a 1-year period. It consists of months selected from individual years and concatenated to form a complete year. The intended use is for computer simulations of solar energy conversion systems and building systems. Learn more about TMY at http://rredc.nrel.gov/solar/pubs/tmy2/tmy2_index.html



The left side of this graph represents the highest demand hours of the year. Hot humid summer afternoons, like today, in Knoxville. To meet that demand the utilities have to pull out all the stops: they run all their power plants at close to maximum production. Of course the rest of the year they don't need all those plants. The plants that are only used 2% of year represent a huge waste of capital. They also don't receive funding to improve their efficiency or the most modern pollution controls.

The dumb grid can't do much about that problem. But with the data from the Smart Grid utilities can start to do smart pricing: varying the price of electricity to more closely match the cost of generating it. Pilot projects have shown that customers will change their consumption patterns to save money. Fortunately for all of us, when customers change their behavior utilities don't have to turn on their oldest, dirtiest, and most expensive power plants, which is what happens now during those 1-200 hours on the left side of the load duration curve.

So Why Am I Here at ESIP?

I am soon going to have a data problem and I'm looking for help. SmartGrid.gov will be collecting data from all 132 ARRA funded Smart Grid projects (www.SmartGrid.gov/projects). Among other things, we will be collecting meter data from 11 million homes. That used to mean 132 million readings/year. Now it's going to be 385,440,000,000 readings per year, because smart meters collect 15 minute data, for five years!

I'm looking for ways to collect, manage, protect, retrieve, ***analyze, share, and visualize all that data.***